Peirce's Concept of Information

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Introduction

Peirce's theory of information provides foundations for our main PhD thesis hypothesis and this is why such concept is one of most important to us in all his philosophical system. To understand this part of Peirce's work it is necessary to understand his three conceptions of information. The first conceives information in a traditional sense as a logical quantity calculated from the quantities of extension and comprehension. The second deals with information in a broader sense, considering the semeiotic and pragmatic aspects (not only verbal symbols, but also iconic and indexical signs and non-verbal symbols). The third takes a metaphysical approach, dealing with information as the imparting of form to matter. In this text, we intend to summarize this concept, showing that all these aspects are linked amongst them. As stated by De Tienne (2006), "*Peirce's pragmatistic theory of information is indissolubly connected to his semiotic theory of propositions, itself an elaborate outgrowth of the traditional subject-predicate propositional logic and of the logic of relatives*". We argue that the third part of this theory is also indissolubly linked to the other two, since an object of representation transmits its respective forms to the sign that represents it for an interpretant determined by the sign. Information gives a *form* in the sense that to know an object we must represent it, sorting out the form from its substance. De Tienne (2005, pp. 153-154) draws a parallel between Peirce's earlier logical conception of information related to subject-predicate terms, and the dichotomy of matter and form. We will introduce this discussion in the last part of this text.

In order to present a concept of sign, it is important to present some preliminary ideas.

One of our main interests in Peirce's work is to make explicit the *logical structure* in the semiotic process. As we know, Peirce (*CP* 2.227) conceives Logic and Semiotic as synonyms. In this sense, a genuine semeiotic process is a triadic relation. As defined by Peirce (*CP* 2.242), "*A Representamen is the First Correlate of a triadic relation, the Second Correlate being termed its Object, and the possible Third Correlate being termed its Interpretant, by which triadic relation the possible Interpretant is determined to be the First Correlate of the same triadic relation to the same Object, and for some possible Interpretant. A Sign is a representamen of which some interpretant is a cognition of a mind. Signs are the only representamens that have been much studied*".

This definition of sign is an abstract one. As we are interested in clarifying the logical *form* of a representative process, this general definition helps us to visualize the iconic aspect of this relation.

For Peirce *Semiose* is a logical structure. The first correlate determinates the second and this second determinates the third. There are signs that do not determinate interpretants of a logical nature, since there are interpretants that can be mere feelings (emotional) or reactions (energetic). In this case, we have a degenerated semeiotic relation, and we can argue that there is no conveyance of information. In a genuine triadic relation, all the correlates are of a representational nature and there are three ways of determination of a sign by its object: the so-called notions of *Icon*, *Index*, and *Symbol*.

Nevertheless, we must remember that as stated by Peirce himself "we can have no reason to think that every phenomenon in all its minutest details is precisely determined by law. […] there is an arbitrary element in the universe, its variety" (*CP* 6.30). This process of determination is

therefore a process in which the chance plays a fundamental role. As we shall see, information is related to the increase of knowledge in the broadest sense of the term "knowledge". The term Increase here means new comprehension. If there was no place to chance in this process of determination, we are conceiving a deterministic view of the physical world and in this world there would not be place to information as well. Chance is therefore necessary to information and plays an important role in the process of determination.

Before summarizing the theory of information in Peirce's writings, we give some preliminaries explanations. In existence there is individualization from duality, from the reaction of this that is not that. This determination is an identification of an object or a set of objects and an ascribing of a quality for it. In pragmatistic terms, there is an indication of a phenomenon and an identification of its qualities. There is a sign that represents an object: the synthesis generates information. Therefore, the notion of representation allows us to understand the process of generating information. What is then information?

1.The first notion of information: a traditional logical approach

In Peirce (1866, Lowell Lecture 7, CE 1, 467) we have: "The information of a term is the measure of its superfluous comprehension. That is to say that the proper office of the comprehension is to determine the extension of the term. For instance, you and I are men because we possess those attributes – having two legs, being rational, &c. – which make up the comprehension of man. Every addition to the comprehension of a term lessens its extension up to a certain point, after that further additions increase the information instead."

A *comprehension* of a term is a set of characteristics ascribed to it; given a term, its comprehension or *intension* consists of the set of predicates that we can ascribe to it (*CP* 2.473; 6.590). The *extension* or *denotation* of a term is the set of all objects that can be denoted by it (*CP* 1.559; 2.473). Let us consider then the following situation: A man contemplating an orange asks: "*Is this orange sweet?*". He is asking for *information* about the taste of the fruit, that is, he wants *to know* more about the objects of the world. Another man cuts the fruit and tastes it and says: "*This orange is sweet*". Now the first man has information about the fruit from an actual message. In this case, from his actual state of information, the extension of the term *sweet*, which corresponds to all sweet objects of his universe, has increased without reducing his comprehension of what means to be sweet. On the other hand, the comprehension of the particular term "*this orange*" has also increased, as now he knows that this orange is sweet, without a decrease of its extension. For this reason, in a proposition, information enlarges the comprehension of the subject and the extension of the predicate.

This is also why information is, by definition, "*that amount of comprehension a symbol has over and above what limits its extension*" (*W*1: 287). Information is therefore a logical quantity. It provides new knowledge about the world and confers realism to our representations (Silveira, 2008, p. 283). By saying that information is a logical quantity, we are saying that information is a result of two other logical quantities. *Quantity* is a measure of the extension of a term. Different terms "may denote more or fewer possible things" (W1:187). Although *quality* is related to the comprehension of a term, it is also quantifiable: exactly the number of attributes of a term (Nöth, 2013, p. 142).

An interesting observation relevant to this subject is made by Nöth (*ibidem*): "That the quality of a term is quantifiable is also apparent in the historical terminology of logic. As Peirce points out, the terms used by many early Kantians for extension and intension [comprehension] were 'external and internal quantity' (*W*2: 72). Intension is hence a quality but also a quantity, not an external, but an internal quantity." Internal quantity is related to the comprehension of the term, its evolutionary history. External is related to the objects that the terms denote (*CP* 2.393).

Another important point is that information is related to interpretants of a sign. If an interpretant is a sign determined by the determination of the first correlate by its object, then the former is a more developed sign, since it is a created in a logical process of growing of knowledge. Information

is "*Instead, information is that kind of interpretant in which symbols are translated into new and more developed symbols*" (Nöth, 2013, p. 145).

We should remember that between the qualities of extension and comprehension there is a relation discovered by Kant, as Peirce (*W*: 2: 84; CP 1.559) pointed out: "*Any addition to the breadth* [extension] *of a term diminishes its depth* [comprehension]" or "*The greater the extension, the less the comprehension*" (*W*1:465).

Terms alone *have* information, inasmuch they have both extension and comprehension, but do not convey it. For example, the term *man* has both extension and comprehension: the former is the set of all the real things that it denotes and the latter is formed by all the predicates that we can ascribe for it (being rational, biped and so on). Despite the impossibility of conveying information, terms are strictly necessary to informativity. Information is conveyed through *propositions*: they allow the growth of information and the acquisition of new knowledge.

From this point, we can present the following formula that "crudely expresses the fact that the greater the extension the less the comprehension" (*W*1: 465):

$$\text{Comprehension x Extension = Information}$$

2. The second notion: the semeiotic one

Peirce (1910, *MS* 664-19) states: "By information I mean all that knowledge that we collect from the experience of ourselves and of others. Now I call **any** acquisition of Knowledge 'information,' which has logically required any other experience than experience of the meanings of words. I do not call the knowledge that a person known to be a woman is an adult nor the knowledge that a corpse is not a woman, by the name of 'Information', because the word 'woman' means a living adult human being having, or having had, female sexuality. Knowledge that is not Informational may be termed 'verbal'."

Peirce's semeiotic studies of the relations between the sign considered in relation to the objects that it represents and to the sign considered in relation to the interpretant, is in accordance with a very wide extension in his theory of information. This more general theory applies to signs in general and not only to verbal symbols.

There is here a great increase of Peirce's conception of information. In his semeiotic, information is a synthesis between index and icon. The former is "[…] *a sign which refers to the Object that it denotes merely by virtue of characters of its own, and which it possesses, just the same, whether any such Object actually exists or not. It is true that unless there really is such an Object, the Icon does not act as a sign; but this has nothing to do with its character as a sign. Anything whatever, be it quality, existent individual, or law, is an Icon of anything, in so far as it is like that thing and used as a sign of it*" (*CP* 2.247). The latter is "[…] *a sign which refers to the Object that it denotes by virtue of being really affected by that Object. It cannot, therefore, be a Qualisign* [Icon]*, because qualities are whatever they are independently of anything else. In so far as the Index is affected by the Object, it necessarily has some Quality in common with the Object, and it is in respect to these that it refers to the Object. It does, therefore, involve a sort of Icon, although an Icon of a peculiar kind; and it is not the mere resemblance of its Object, even in these respects which makes it a sign, but it is the actual modification of it by the Object.*"

As in the case of terms alone, pure icons and genuine indices do not convey information, although information can be derived from them. According to Nöth (2008, p. 152), (**i**) "[…] *pure icons are rhemes* [terms] *from which information can only be derived*"; and (**ii**) "*they are inherently vague, representing nothing but mere possibilities*". The following quote suggests why a pure icon is incapable of conveying information: "*The idea embodied by an icon … cannot of itself convey any information, being applicable to everything or to nothing*" (*CP* 3.433).

Why a genuine index does not convey any type of information? Peirce (*CP* 3.361) says, "The index asserts nothing; it only says 'There!' It takes hold of our eyes, as it were, and forcibly directs

them to a particular object, and there it stops". Furthermore, as stated by De Tienne (2003, p. 49), "An index without an icon is blind, a symbol without an index is empty. Pure indexes and pure symbols do not occur, except within the abstract classification of semiotic theory, where their isolation is of course most convenient".

We should notice that indices and icons are *necessary* to information. We can relate the notions of subjects and predicates to that of indices and icons. Indeed, as pointed out by Peirce (see W1: 272), a term has both comprehension and extension in virtue of having a meaning and being applicable to objects. He then calls the *meaning* of a term its *connotation* and its applicability or reference to things its *denotation*, in the sense that every symbol denotes by connoting. If a representation process only denotes but does not connote, then it is a mere index. If, on the other hand, this representation only connotes but does not denote, it is a mere icon.

A proposition is a dicent symbol that incorporates an index and an icon. Together, index, icon, and symbol can convey information. The synthesis between both index and icon generates information. Because of this, information must be embodied by an icon and denoted by an index. This broader conception suggests that not only verbal symbols convey information, but also non-verbal signs in general, as pictures, for example.

In what sense does a non-verbal sign convey information? The typical Peircean instance is a weathercock.

As to weathercock, Peirce (*CP* 2.286) states that it is an index of the direction of the wind, since the sign is really affected by its object. The index takes the same direction as the wind, so that there is a real connection between them. Besides that, we are so familiarized with this network of signs that when we see a weathercock pointing in a certain direction it draws our attention to that direction, and we are able in verifying that the sign is connected with the wind.

Peirce (*CP* 2.257) then says: "A Dicent Sinsign is any object of direct experience [as a weathercock], in so far as it is a sign, and, as such, affords information concerning its Object [the wind direction]. This it can only do by being really affected by its Object; so that it is necessarily an Index. The only information it can afford is of actual fact. Such a Sign must involve an Iconic Sinsign [any object of experience in so far as some quality of it determine the idea of an object (*CP* 2.255)] to embody the information and a Rhematic Indexical Sinsign [any object of direct experience so far as it directs attention to an Object by which its presence is caused (*CP* 2.256)] to indicate the Object to which the information refers. But the mode of combination, or Syntax, of these two must also be significant."

Nöth (2008, p. 156, emphasis added) concludes: "Here [in the quote above], Peirce says explicitly that to convey information, a sign does not need to be a symbol, which extends **Peirce's early theory of information, which was restricted to symbols**."

During the time in which Peirce extended his theory of information, he was concerned about other issues that were directly related to these changes in aspects of information. According to Romanini's seminar, presented at the Centre for Logic, Epistemology, and the History of Science (UNICAMP – BRAZIL), in 2016: "*In Peirce's semeiotic, the information must be:*(**i**) *Embodied by an icon;* (**ii**) *Denoted by an index (quantifier);*(**iii**) *Conveyed by a symbol;* (**iv**) *Dicent symbols (propositions) are by their own definition always informative signs;* (**v**) *Deduction comes into play in his theory of inquiry: 'A Necessary Deduction is a method of producing Dicent Symbols by the study of a diagram'. (CP 2.267); and* (**vi**) *reasoning now involves abduction, induction and deduction: 'The purpose of reasoning is to proceed from the recognition of the truth we already know to the knowledge of novel truth'* (CP 4.476)". Romanini (2016) also discusses the essential properties of Peirce's semeiotic information: "(**i**) *Information can be extracted from diagrams (coded relations) by reasoning;*(**ii**) *Information is modal and relative to an Universe (real or fictional);* (**iii**) *Information is relative to a state of knowledge about* **such** *Universe; and* (**iv**) *there must always be* **collateral** *information (familiarity) about the object represented by the symbol, be it real or fictional.*"

3. The third notion: the metaphysical one

Peirce (*CP* 2.420) states: "Analogous to increase of information in us, there is a phenomenon of nature —development— by which a multitude of things come to have a multitude of characters, which have been involved in few characters in few things."

This quote indicates that Peirce reviewed his previous theory of information, making it realistic. Again, we summarize some consequences of his conception according to Romanini (2016): "(**i**) *There are real natural classes;* (**ii**) *The symbol is an embryonic reality;* (**iii**) *Information is the growth of symbols;* (**iv**) *Form is a "would-be"; and* (**vi**) *Information is development, increase of complexity in reality.*"

Peirce (*EP*1 307-8) says, "Consider the life of an individual animal or plant; or of a mind. Glance at the history of states, of institutions, of language, of ideas. Examine the successions of forms shown by paleontology, the history of the globe as set forth in geology, of what the astronomer is able to make out concerning the changes of stellar systems. Everywhere the main fact is growth and increasing complexity."

The idea of symbol, from this metaphysical point of view, shows a necessary enlargement of the concepts in Pierce's work: ***I use it*** [the term *symbol*] ***to mean a sign to which a general idea is attached by virtue of a habit, which may have been deliberately instituted, or may have grown up in a natural way, and perhaps have been acquired with one's mother milk, or even by heredity***" (*CP* 2.297, emphasis added).

According to Romanini (2016), *the central point in defining a Symbol is that the Form it communicates is the nature of a conditional future*. As we have said before, we consider that type of sign that has logical interpretants. Peirce then affirms: "*To this may be added the consideration that it is not all signs that have logical interpretants, but only intellectual concepts and the like; and these are all either general or intimately connected with generals, as it seems to me. This shows that the species of future tense of the logical interpretant is that of the conditional mood, the 'would-be'*" (*CP* 5.482).

In this third aspect, information would be in-formation, in the sense that it gives form to the object and allows the scientific mind (that one that is capable of learning from experience) to understand this same object by sorting its form out from it in their representations in an infinite semiotic process. This is a metaphysical conception, in which information *is* the connection of form and matter (*CP* 2.418). Matter is related to the subject, and Idea or Form is related to the predicate. Peirce affirms that the "*being* [of form] *is a being of the predicate*" (*W*2: 544). This brings us the idea of synthesis or connection between the subjects and predicates or between icons and indices.

Now we are able to better understand Peirce's statement that "a Sign may be defined as a Medium for the communication of a Form" (*EP* 2:544). In this sense, as outlined above, the form, "[…] communicated from the object through the Sign to the Interpretant" (*ibidem*), is already embodied in the object of the representation "as the object's potential to create the same effect of signification which the sign creates when it represents the object. Form is embodied representatively in the symbol insofar as the Form communicated by the object of the Sign 'produces upon the interpretant an effect similar to that which the Object itself would under favorable circumstances'" (Nöth, 2008, p. 160).

How is it possible that an object could be a symbol? Peirce affirms: "[…] the die has a certain 'would-be'; and to say that a die has a 'would-be' is to say that it has a property, quite analogous to any habit that a man might have. Only the 'would-be' of the die is presumably as much simpler and more definite than the man's habit as the die's homogeneous composition and cubical shape is simpler than the nature of the man's nervous system and soul; and just as it would be necessary, in order to define a man's habit, to describe how it would lead him to behave and upon what sort of occasion –albeit this statement would by no means imply that the habit consists in that action– so to define the die's 'would-be', it is necessary to say how it would lead the die to behave on an occasion

that would bring out the full consequence of the 'would-be'; and this statement will not of itself imply that the 'would-be' of the die consists in such behavior." (*CP* 2.664). Therefore: "[…] the external world, […] does not consist of existent objects merely, nor merely of these and their reactions; but on the contrary, its most important reals have […] general types and would-bes. The nominalist is right in saying that they are substantially of the nature of words; but his 'mere' reveals a complete misunderstanding of what our everyday world consists of" (*CP* 8.191).

Conclusion

Information is thus a logical quantity related to the increase of complexity in the world, a type of comprehension that all scientific minds are able to have. These minds represent the object, sorting its forms out from it through information in a semiotic process. The conveyance of information is possible through signs which interpretant is determined by logical necessity, forming a network in an infinite evolution.

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